Continuous hydrodeoxygenation of lignin to jet-range aromatic hydrocarbons

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Project Goals: The Center for Bioenergy Innovation (CBI) vision is *to accelerate domestication of bioenergy-relevant, non-model plants and microbes to enable high-impact innovations at multiple points in the bioenergy supply chain.* CBI addresses strategic barriers to the current bioeconomy in the areas of 1) high-yielding, robust feedstocks, 2) lower capital and processing costs via consolidated bioprocessing (CBP) to specialty biofuels, and 3) methods to create valuable byproducts from the lignin. CBI will identify and utilize key plant genes for growth, composition, and sustainability phenotypes as a means of achieving lower feedstock costs, focusing on poplar and switchgrass. We will convert these feedstocks to biofuels using CBP with cotreatment at high rates, titers and yield in combination with catalytic upgrading into drop-in hydrocarbon fuel blendstocks.

The need for sustainable aviation fuels (SAFs) is highlighted by the increasing global demand for air travel, which is expected to more than double by 2050. Meanwhile, the IATA is currently aiming to decrease carbon emissions from aviation sources by half relative to 2005 levels within the same timeframe. Current SAFs are limited in that they fail to provide the requisite aromatic content to obtain the necessary physical properties to function as a drop-in fuel substitute, necessitating a 50% blend limit with conventional jet fuels. This underscores an interesting opportunity to convert lignin, the largest source of renewable aromatics available in nature, to jet-range aromatic blendstocks, thereby allowing for the production of a 100% renewable SAF. Deoxygenation technologies are essential for the upgrading of lignin for applications in aviation fuels, as lignin possesses an extremely high oxygen content (27-34 wt%) relative to the trace levels allowable in aviation fuels. Here, we demonstrate a flowthrough process combining reductive catalytic fractionation (RCF) with hydrodeoxygenation to selectively produce a stream of deoxygenated aromatic hydrocarbons from raw lignocellulosic biomass. Using a dual-pass system and a three-phase trickle-bed reactor, we both evaluate catalyst stability while achieving complete deoxygenation of a neat poplar lignin oil derived from RCF with an overall 73 C-mol% recovery (86% of theoretical when accounting for methoxy groups). Through a suite of characterization techniques, the product stream's properties were subsequently evaluated for use in aviation fuels. This process demonstrates a simple system for generating SAF blendstocks from lignin, the properties and product distributions of which can potentially be tuned via using different biomass types and their corresponding *in planta* lignin composition.

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